

V.3.3-UNIT-HG UNIT HYDROGRAPH OPERATION

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Application: All programs

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Description: This Operation converts runoff volumes computed by a rainfall-runoff Operation into instantaneous discharges.

The special provisions of this Operation include the following:

1. The duration of the unit hydrograph is assumed to be equal to the data time interval of the runoff time series.
2. The data time interval of the unit hydrograph ordinate spacing must be the same as the data time interval of the instantaneous discharge time series.
3. The data time interval of the runoff time series must be an even

Card    Format    Columns    Contents

multiple of the instantaneous discharge time series data time interval.

4. Initial unit graph carryover values can be specified by the user. The carryover values consist of runoff time series values. The number of values is equal to the number of unit graph ordinates minus one, divided by the ratio of the runoff time series data time interval to the discharge time series data time interval. The default values are zeroes.
5. The user can specify a baseflow to be added to the computed instantaneous discharges. The baseflow can consist of two parts: constant and variable. If the variable baseflow option is to be used, the user must specify a daily recession coefficient. In the Operational Forecast Program, the baseflow amounts and the recession coefficient can be changed through the use of run-time modifications (MODs). This option is primarily for use with API Operations.
6. Input to this Operation can be in either metric or English units.

A complete description of this Operation is in Chapter II.4-UNIT-HG.

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Allowable Data Time Intervals: 1, 2, 3, 4, 6, 8, 12 and 24 hours

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Time Series Used: Time series used in this Operation are as follows:

General Type	Dimn	Units	Use	Required	Form of Output T.S.	Data Time Interval	Missing Values Allowed
Runoff	L	MM	I	yes	n/a	any	no
Instantaneous discharge	L3/T	CMS	O	yes	additive	any <u>1</u> /	no

1/ The runoff time series data time interval must be an even multiple of the instantaneous discharge time series.

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Input Summary: The card input for this Operation is as follows:

Card    Format    Columns    Contents

1	5A4	1-20	General information for this Operation
	5X,F10.1	26-35	Drainage area to be represented by unit

<u>Card</u>	<u>Format</u>	<u>Columns</u>	<u>Contents</u>
			hydrograph (units of KM2 or MI2)
	2X,13	38-40	Number of ordinates in the unit hydrograph; first ordinate is at the end of the first data time interval
	2A,2A4	46-50	Enter 'CARRY' to input initial carryover values; default is initial value of zero
	1X,A4	52-55	Option to specify units of input: <ul style="list-style-type: none"> <li>o enter 'METR' to specify metric units</li> <li>o enter 'ENGL' to specify English units</li> </ul> default is METR
	F10.3	56-65	Constant baseflow to be added to computed instantaneous discharges (units of CMS or CFS) <ul style="list-style-type: none"> <li>o primarily for use with API Operations</li> <li>o enter 0.0 if currently no constant baseflow</li> </ul>
	4X,I1	70	Indicator to allow optional variable baseflow; enter '1' to specify that variable baseflow input will follow on Card 2

Card 2 is optional and should only be used if column 70 of Card 1 is '1'.

2	F5.4		Variable baseflow daily recession coefficient; must be greater than or equal to 0.5 and less than 1.0
	F10.3		Total baseflow to be added to computed instantaneous discharges <ul style="list-style-type: none"> <li>o includes constant baseflow from Card 1 and variable baseflow (CMS or CFS)</li> <li>o primarily for use with API Operations</li> <li>o equals constant baseflow if currently no variable component</li> </ul>
3	2X,2A4	3-10	Internal identifier for the runoff time series
	1X,A4	12-15	Data type code for runoff time series.
	3X,I2	19-20	Data time interval of runoff time series (HR) (computational time interval of the Operation)

<u>Card</u>	<u>Format</u>	<u>Columns</u>	<u>Contents</u>
	2X,2A4	23-30	Identifier for the instantaneous discharge time series
	1X,A4	32-35	Data type code for the discharge time series
	3X,I2	39-40	Data time interval of discharge time series in hours (spacing of the unit hydrograph ordinates)
4	7F10.4	1-70	Unit hydrograph ordinates (units of CMS/MM or CFS/IN); repeat card 4 as many times as is necessary to read in the entire unit hydrograph (7 values per card)

Card 5 is optional and should only be used if columns 46-50 of Card 1 is 'CARRY'.

5	7F10.4	1-70	Initial unit hydrograph carryover values (units of MM or IN) <ul style="list-style-type: none"> <li>o repeat card 5 as many times as is necessary (7 values per card)</li> <li>o carryover is the previous runoff values; the number of carryover values is:  <math>(n-1) * (\Delta t / \Delta T)</math> where: <ul style="list-style-type: none"> <li>n = number of ordinates</li> <li><math>\Delta t</math> = ordinate spacing (units of HR)</li> <li><math>\Delta T</math> = runoff duration (units of HR)</li> </ul> </li> </ul> The last value is the most recent.
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Sample Input and Output: Sample input is shown in Figure 1 [[Bookmark](#)]. Sample output from the parameter print and carryover print routines is shown in Figure 2 [[Bookmark](#)]. There is no execution routine output.

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Error and Warning Messages: The error and warning messages generated by this Operation and the corrective action to take when they occur are as follows:

A. Messages that can occur during setup.

1. **\*\*WARNING\*\*** THE ENGLISH METRIC SWITCH MUST BE 'METR', 'ENGL', OR BLANK. THE VALUE ENTERED IS XXXX. METRIC IS ASSUMED.

Action: Check the spelling of the English-metric units

switch.

2. **\*\*ERROR\*\*** THE RECESSION COEFFICIENT MUST BE GREATER THAN OR EQUAL TO 0.5 AND LESS THAN 1.0. X.XXXX WAS SPECIFIED.

Action: Check value specified for recession coefficient.

3. **\*\*WARNING\*\*** THE TOTAL BASEFLOW MUST BE GREATER THAN OR EQUAL TO THE CONSTANT BASEFLOW. XXXXXX.XXX WAS SPECIFIED. THEY WILL BE SET EQUAL.

Action: Check baseflow input.

4. **\*\*ERROR\*\*** THE TIME INTERVAL OF THE RUNOFF TIME SERIES (XX HOURS) IS LESS THAN THE TIME INTERVAL OF THE DISCHARGE SERIES (YY HOURS).

Action: Check the data time intervals of the runoff and discharge time series and redefine if necessary.

5. **\*\*ERROR\*\*** THE TIME INTERVAL OF THE RUNOFF TIME SERIES (XX HOURS) IS NOT AN EVEN MULTIPLE OF THE TIME INTERVAL OF THE DISCHARGE SERIES (YY HOURS).

Action: Check the data time intervals of the runoff and discharge time series and redefine if necessary.

6. **\*\*ERROR\*\*** THE TOTAL LENGTH OF THE UNIT HYDROGRAPH (XX HOURS) IS LESS THAN THE TIME INTERVAL OF THE RUNOFF TIME SERIES (YY HOURS).

Action: Check the data time intervals of the runoff and discharge time series and redefine if necessary, or add ordinates to the unit hydrograph.

7. **\*\*WARNING\*\*** THE AREA REPRESENTED BY THE UNIT HYDROGRAPH (XXXXXX.X SQ.ZZ) DIFFERS FROM THE USER SPECIFIED AREA (YYYYYY.Y SQ.ZZ) BY MORE THAN ONE PERCENT.

Action: Check the ordinates in the unit hydrograph.

8. **\*\*WARNING\*\*** THE SPECIFIED UNIT HYDROGRAPH WILL NOT PROVIDE ANY CARRYOVER VALUES.

Action: Check the number of ordinates in the unit graph and the data time intervals of the runoff and discharge time series.

B. Message that can occur during carryover transfer.

1. **\*\*WARNING\*\*** NEITHER THE OLD (XX HOURS) NOR THE NEW (YY HOURS) RUNOFF TIME SERIES TIME INTERVAL IS AN EVEN MULTIPLE OF THE OTHER. NO CARRYOVER VALUES CAN BE TRANSFERRED.

Action: Check the data time intervals of the old and new runoff time series.

Carryover Transfer Rules: The following rules apply during the carryover transfer process:

1. Carryover values are runoff values + optional variable baseflow.
2. If the new runoff time series data time interval ( $\Delta T_{new}$ ) is not equal to the old runoff time series data time interval ( $\Delta T_{old}$ ) and
  - a. if  $\Delta T_{new}$  is a multiple of  $\Delta T_{old}$ , runoff values are adjusted by summing the values which fall within a  $\Delta T_{new}$  interval.
  - b. If  $\Delta T_{old}$  is a multiple of  $\Delta T_{new}$ , runoff values are adjusted by dividing each value by  $(\Delta T_{old}/\Delta T_{new})$ .
  - c. If neither  $\Delta T_{old}$  nor  $\Delta T_{new}$  is a multiple of the other, carryover is not transferred.
3. The number of new carryover values is equal to the number of new unit hydrograph ordinates minus one, divided by the ratio of the new runoff time series data time interval to the new discharge time series data time interval.
  - a. If the number of new carryover values is less than the number of old values (or adjusted values if adjustment was made), the most recent values are saved as carryover.
  - b. If the number of new carryover values is greater than the number of old values (or adjusted values if adjustment was made), zeroes are added prior to the earliest runoff values.
4. If variable baseflow is used in both old and new definitions, the new total baseflow is equal to the old total baseflow or the new constant baseflow, whichever is larger..

Card Punch Limitations: The punched card formats for this Operation are as follows. No checks are made to determine if quantities are greater or less than the maximum and minimum values.

<u>Parameters or Variables</u>	<u>Punch Format</u>	<u>Maximum Value</u>	<u>Minimum Value</u>	<u>Precision After Decimal Point</u>
Area (specified drainage area)	F10.1	99999999.9	0.1	tenths
Baseflow constant	F10.3	999999.999	0.001	thousandths
Baseflow recession coefficient	F5.4	.9999	0.0001	ten-thousandths
Total baseflow	F10.3	999999.999	0.001	thousandths

(constant +  
variable)

Unit graph ordinates	F10.4	99999.9999	0.0001	ten-thousandths
Initial carryover values	F10.4	99999.9999	0.0001	ten-thousandths

Figure 1. Sample card input for Operation UNIT-HG

```

          - Column -
    5    10    15    20    25    30    35    40    45    50    55    60    65    70    75    80
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
PECATONICA AFTON                395.0  10                ENGL      0.000
  AFTNC    INFW    6  AFTNCROQ SQIN    6
2000.    6300.    7050.    7500.    7000.    5400.    3900.
2100.    1000.    300.
  
```

Figure 2. Sample output from Operation UNIT-HG print parameter and print carryover routines

```

UNIT HYDROGRAPH OPERATION FOR PECATONICA AFTON
  COMPUTATIONAL TIME INTERVAL IS  6 HOURS.
    TIME SERIES USED BY THIS OPERATION.
      CONTENTS                I.D.        TYPE        TIME INTERVAL
CHANNEL INFLOW (RUNOFF)  AFTNC        INFW        6 HOURS
INSTANTANEOUS DISCHARGE  AFTNCROQ    SQIN        6 HOURS
  6-HOUR UNIT HYDROGRAPH:  10 ORDINATES DEFINED AT  6-HOUR INTERVALS
THE UNIT HYDROGRAPH REPRESENTS AN AREA OF ABOUT  395.6 SQ.MI.
ORDINATE      1      2      3      4      5      6      7      8      9      10
Q (CFS/IN)   2000.  6300.  7050.  7500.  7000.  5400.  3900.  2100.  1000.  300.
NO BASEFLOW WILL BE ADDED TO THE COMPUTED DISCHARGES.
UNIT HYDROGRAPH CARRYOVER VALUES FOR PECATONICA AFTON
INITIAL CARRYOVER VALUES HAVE BEEN SET TO ZERO.
  
```